must, therefore, be of the very highest order. His scientific training and his world-wide practice have broadened his views and enlarged his mind. Above all, his character must be above all reproach. The honour of the engineer is the honour of his profession. The Lord Chief Justice's Bill was welcomed by every member of the Institution of Civil Engineers. The evil it is desired to suppress is very great and very wide, but it is not the characteristic of the engineer.

Let me, in conclusion, impress on you the antiquity and the universality of the functions of the engineer. Tubal-Cain was an instructor of every artificer in brass and iron, and this before the flood. The very earliest remains of Egyptian, Babylonian and Assyrian temples and monuments indicate a wonderful knowledge of the strength of materials. The Cloaca Maxima of the early Latin King Tarquinius Priscus exists still, though built 2,600 years ago. In the track of war and diplomacy, in the earliest days of history, went trade and commerce. The general became the engineer. Western Asia was covered with roads, not only to facilitate the transport of troops and chariots, but to assist the merchant in the distribution of his wares. Intercourse of all kinds has always been the outcome of civilisation. The balance of power falls to the strong. In days of old it was to the strong physically. In modern days it is more to the strong mentally and financially. The greatest political gift that mind can give to man, the greatest security for peace and comfort, is the ability to wield the great powers of nature so as to destroy human life with the greatest rapidity and at the greatest distance. An overpowering fleet and an efficient army are our insurance for security at home. There is not a habitable spot on the face of the earth that does not bear traces of the presence of the engineer. He is the great civiliser. He not only immediately follows, but he sometimes even precedes the military conqueror. He distributes peace and good-will without the accompaniments of fire, blood and famine. Mr. Cecil Rhodes is opening up Africa with the "wonder-working wire." Khartoum has been brought within seventy hours of Cairo by train, and ere long, when peace is restored in that self-disturbed country, South Africa, Cairo and Cape Town will be in direct and immediate communication by telegraph, and eventually by rail.

The engineer is not only a benefactor to his race, but he is a necessity of the age.

WIRELESS TELEGRAPHY.[1]

When Ampère threw out the suggestion that the theory of a universal ether, possessed of merely mechanical properties, might supply the means for explaining electrical facts, which view was upheld by Joseph Henry and Faraday, the veil of mystery which had enveloped electricity began to lift. When Maxwell published, in 1864, his splendid dynamical theory of the electro-magnetic field, and worked out mathematically the theory of ether waves, and Hertz had proved experimentally the correctness of Maxwell's hypothesis, we obtained, if I may use the words of Prof. Fleming, "the greatest insight into the hidden mechanisms of nature which has yet been made by the intellect of man."

A century of progress such as this has made wireless telegraphy possible. Its basic principles are established in the very nature of electricity itself. Its evolution has placed another great force of nature at our disposal.

We cannot pay too high a tribute to the genius of Heinrich Hertz, who worked patiently and persistently in a new field of experimental physics, and made what has been called the greatest discovery in electrical science in the latter half of the nineteenth century. He not only brought about a great triumph in the field of theoretical physics, but, by proving Maxwell's mathematical hypothesis, he accomplished a great triumph in the progress of our knowledge of physical agents and physical laws.

I cannot forbear saying one word as to the eminent electrician who was placed in his last home as recently as Saturday last, for it is manifest that several years ago Prof. Hughes was on the verge of a great discovery, and, if he had persevered in his experiments, it seems probable that his name would have been closely connected with wireless telegraphy as it is with so many branches of electrical work in which he gained so much renown and such great distinction.

The experimental proof by Hertz thirteen years ago, of the identity of light and electricity, and the knowledge of how to produce, and how to detect these ether waves, the existence of which had been so far unknown, made possible true wireless telegraphy. I think I may be justified in saying that for several years the full importance of the discovery of Hertz was realised but by very few, and for this reason the early development of its practical application was slow.

The practical application of wireless telegraphy at the *present* time is many times as great as the predictions of five years ago led us to expect in so short a time. The development of the art during the past three or four years, and its present state of progress, may perhaps justify the interest which is now taken in the subject. Yet only a beginning has been made, and the possibilities of the future can as yet be only incompletely appreciated. All of you know that the idea of communicating intelligence without visible means of connection is almost as old as mankind. Wireless telegraphy by means of Hertzian waves is, however, very young. I hope that if I pass over the story of the growth of this new art, as I have watched it, or do not attempt to prove questions of priority, no one will take it for granted that nothing is to be said on these subjects, or that all that *has* been said is entirely correct.

The time allowed for this discourse is too short to permit me to recount all the steps that have led up to the practical applications of to-day. I believe it will probably interest you more to hear of the problems which have lately been solved, and the very interesting developments which have taken place during the last few months.

I find that a great element of the success of wireless telegraphy is dependent upon the use of a coherer such as I have adopted. It has been my experience, and that of other workers, that a coherer as previously constructed—that is, a tube several inches long partially filled with filings enclosed by corks—was far too untrustworthy to fulfil its purpose. I found, however, that if specially prepared filings were confined in a very small gap (about 1 mm.) between flat plugs of silver, the coherer, if properly constructed, became absolutely trustworthy. In its normal condition the resistance of a good coherer is infinite, but when influenced by electric waves the coherer instantly becomes a conductor, its resistance falling to 100 or 500 ohms. This conductivity is maintained until the tube is shaken or tapped.

I noticed that by employing similar vertical and insulated rods at both stations it was impossible to detect the effects of electric waves of high frequency, and in that way convey the intelligible alphabetical signals, over distances far greater than had been believed to be possible a few years ago.

I had formerly ascertained (see paper read before the Institution of Electrical Engineers by G. Marconi, March 1899) that the distance over which it is possible to signal with a given amount of energy varies approximately with the square of the height of the vertical wire, and with the square root of the capacity of a plate, drum, or other form of capacity area which may be placed at the top of the wires.

The law governing the relation of height and distance has already been proved correct up to a distance of 85 miles. Many months ago it was found possible to communicate from the North Haven, Poole, to Alum Bay, Isle of Wight, with a height of 75 feet, the distance being 18 miles. Later on two installations with vertical wires of double that length, *i.e.* 150 feet, were erected at a distance of 85 miles apart, and signals were easily obtained between them. According to a rigorous application of the law, 72 miles ought to have been obtained instead of 85; but, as I have previously stated, the law has been proved only to be approximately correct, the tendency being always on what I might call the right side; thus we obtain a greater distance than the application of the law would lead us to believe. There is a remarkable circumstance to be noted in the case of the 85 miles signalling. At the Alum Bay station the mast is on the cliff, and there is no curvature of the earth intervening between the two stations; that is to say, a straight line between the base of the Haven and Alum Bay stations would clear the surface of the sea. But in the case of the 85 miles the two stations were located on the sea-level, and between them exists a hill of water, owing to the earth's curvature, amounting to over 1000 feet. If these waves travelled only in straight lines, or the effect was noticeable only across open space, in a direct line, the signals would not have been received, except with a vertical wire 1000 feet high at both stations.

While carrying out some experiments nearly three years ago at Salisbury, Captain Kennedy, R.E., and I tried numerous forms of induction coils wound in the ordinary way, that is, with a great number of turns of wire on the secondary circuit, with the object of increasing, if possible, the distance or range of transmission, but in every case we observed a very marked decrease in the distance obtainable with the given amount of energy and height. Similar results were obtained some months later, I am informed, in experiments carried out by the General Post Office Engineers at Dover.

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[1] Abridged from a discourse delivered at the Royal Institution, on February 2, by Mr. G. Marconi.

In all our above-mentioned experiments the coils used were those in which the primary consisted of a smaller or larger number of turns of comparative thick wire, and the secondary of several layers of thinner wire. I believe I am right in saying that hundreds of these coils were tried, the result always being that by their employment the possible distance of signalling was considerably diminished instead of being increased. We eventually found an entirely new form of induction coil that would work satisfactorily, and that began to increase the distance of signalling.

The results given by some of the new form of induction coils have been remarkable. During the naval manœuvres I had an opportunity of testing how much they increased the range of signalling with a given amount of energy and height. When working between the cruisers *Juno* and *Europa*, I ascertained that when the induction coil was omitted from the receiver, the limit distance obtainable was seven miles, but with an improved form of induction coil included, a distance of over sixty miles could be obtained with certainty. This demonstrated that the coils I used at that time increased the possible distance nearly tenfold. I have now adopted these induction coils, or transformers, at all our permanent stations.

A number of experiments have been carried out to test how far the Wehnelt brake was applicable in substitution for the ordinary make and break of the induction coil at the transmitting station, but although some excellent results have been obtained over a distance of forty miles of land, the amount of current used, and the liability of the brake getting fatigued or out of order, have been obstacles which have so far prevented its general adoption.

As is probably known to most of you, the system has been in practical daily operation between the East Goodwin Lightship and the South Foreland Lighthouse since December 24, 1898, and I have good reason for believing that the officials of Trinity House are convinced of its great utility in connection with lightships and lighthouses. It may be interesting to you to know that, as specially arranged by the authorities of Trinity House, although we maintain a skilled assistant on the lightship, he is not allowed to work the telegraph. The work is invariably done by one of the seamen on the lightship, many of whom have been instructed in the use of the instrument by one of my assistants. On five occasions assistance has been called for by the men on board the ship, and help obtained in time to avoid loss of life and property. Of these five calls for assistance, three were for vessels run ashore on the sands near the lightship, one because the lightship herself had been run into by a steamer, and one to call a boat to take off a member of the crew who was seriously ill.

In the case of a French steamer which went ashore off the Goodwins, we have evidence, given in the Admiralty Court, that, by means of one short wireless message, property to the amount of 52,588*l.* was saved; and of this amount, I am glad to say, the owners and crews of the lifeboats and tugs received 3000*l.* This one saving alone is probably sufficient in amount to equip all the lightships round England with wireless telegraph apparatus more than ten times over. The system has also been in constant use for the official communication between the Trinity House and the ship, and is also used daily by the men for private communication with their families, &c.

It is difficult to believe that any person who knows that wireless telegraphy has been in use between this lightship and the South Foreland day and night, in storm and sunshine, in fog and in gales of wind, without breaking down on any single occasion, can believe, or be justified in saying, that wireless telegraphy is untrustworthy or uncertain in operation. The lightship installation is, be it remembered, in a small damp ship, and under conditions which try the system to the utmost. I hope that before long the necessary funds will be at the disposal of the Trinity House authorities, in order that communication may be established between other lightships and lighthouses and the shore, by which millions of pounds' worth of property and thousands of lives may be saved.

At the end of March 1899, by arrangement with the French Government, communication was established between the South Foreland Lighthouse and Wimereux, near Boulogne, over a distance of thirty miles, and various interesting tests were made between these stations and French warships. The maximum distance obtained at that time, with a height of about one hundred feet on the ships, was forty-two miles. The commission of French naval and military officers who were appointed to supervise these experiments, and report to their Government, were in almost daily attendance on the one coast or the other for several weeks. They became intensely interested in the operations, and I have good reasons to know made satisfactory reports to their Government. I cannot allow this opportunity to pass without bearing willing testimony to the courtesy and attention which characterised all the dealings of these French gentlemen with myself and staff.

The most interesting and complete tests of the system at sea were, however, made during the British naval manœuvres. Three ships of the "B" fleet were fitted up, the flagship *Alexandra*, and the cruisers *Juno* and *Europa*. I do not consider myself quite at liberty to describe all the various tests to which the system was put, but I believe that never before were Hertzian waves given a more difficult or responsible task. During these manœuvres I had the pleasure of being on board the *Juno*, my friend, Captain Jackson, R.N., who had done some very good work on the subject of wireless telegraphy before I had the pleasure of meeting him, being in command. With the *Juno* there was usually a small squadron of cruisers, and all orders and communications were transmitted to the *Juno* from the flagship, the *Juno* repeating them to the ships around her. This enabled evolutions to be carried out even when the flagship was out of sight. This would have been impossible by means of flags or semaphores. The wireless installations on these battleships were kept going night and day, most important manœuvres being carried out and valuable information telegraphed to the Admiral when necessary.

The greatest distance at which service messages were sent was 60 nautical miles, between the *Europa* and the *Juno*, and 45 miles, between the *Juno* and the *Alexandra*. This was not the maximum distance actually obtained, but the distance at which, under all circumstances and conditions, the system could be relied upon for certain and regular transmission of service messages. During tests messages were obtained at no less than 74 nautical miles (85 land miles).

As to the opinion which naval experts have arrived at concerning this new method of communication, I need only refer to the letters published by naval officers and experts in the columns of the *Times* during and after the period of the autumn manœuvres, and to the fact that the Admiralty are taking steps to introduce the system into general use in the navy.

As you will probably remember, victory was gained by the "B" fleet, and perhaps I may venture to suggest that the facility which Admiral Sir Compton Domville had of using the wireless telegraph in all weathers, both by day and night, contributed to the success of his operations.

Commander Statham, R.N., has published a very concise description of the results obtained in the *Army and Navy*, illustrated, and I think it will be interesting if I read a short extract from the admirable description he has published.

"When the reserve fleet first assembled at Tor Bay, the *Juno* was sent out day by day to communicate at various distances with the flagship, and the range was speedily increased to over 30 miles, ultimately reaching something like 50 miles. At Milford Haven the *Europa* was fitted out, the first step being the securing to the main topmast head of a hastily prepared spar carrying a small gaff or sprit, to which was attached a wire, which was brought down to the starboard side of the quarterdeck through an insulator and into a roomy deck house on the lower after-bridge which contained the various instruments.

When hostilities commenced the *Europa* was the leading ship of a squadron of seven cruisers despatched to look for the convoy at the rendezvous. The *Juno* was detached to act as a link when necessary and to scout for the enemy, and the flagship of course remained with the slower battle squadron. The *Europa* was in direct communication with the flagship long after leaving Milford Haven, the gap between reaching to 30 or

40 miles before she lost touch while steaming ahead at a fast speed. (This difference between the ranges of communication on these ships was owing to the *Juno* having a higher mast than the *Alexandra*).

"Reaching the convoy at four o'clock one afternoon, and leaving it and the several cruisers in charge of the senior captain, the *Europa* hastened back towards another rendezvous, where the Admiral had intended remaining until he should hear whether the enemy had found and captured the convoy; but scarcely had she got well ahead of the slow ships when the *Juno* called her up and announced the Admiral coming to meet the convoy. The *Juno* was at this time fully 60 miles distant from the *Europa*.

"Now imagine," says Commander Statham, "a chain of vessels 60 miles apart. Only five would be necessary to communicate some vital piece of intelligence a distance of 300 miles, receive in return their instructions, and act immediately all in the course of half an hour or less. This is possible already. Doubtless a vast deal more will be done in a year or two or less, and meanwhile the authorities should be making all necessary arrangements for the universal application of wireless telegraphy in the navy."

The most important results, from a technical point of view, obtained during the manœuvres were the proof of the great increase of distance obtainable by employing the transformer in the receiver, as already explained, and also that the curvature of the earth which intervened, however great the distance attained, was apparently no obstacle to the transmission. The maximum height of the top of the wire attached to the instruments above the water did not on any occasion exceed 170 feet, but it would have been geometrically necessary to have had masts 700 feet high on each ship in order that a straight line between their tops should clear the curved surface of the sea when the ships were 60 nautical miles apart. This shows that the Hertzian waves had either to go over or round the dome of water 530 feet higher than the tops of the masts or to pass through it, which latter course I believe would be impossible.

Some time after the naval manœuvres, with a view to showing the feasibility of communicating over considerable distances on land, it was decided to erect two stations, one at Chelmsford and another at Harwich, the distance between them being 40 miles. These installations have been working regularly since last September, and my experiments and improvements are continually being carried out at Chelmsford, Harwich, Alum Bay, and North Haven, Poole.

In the month of September last, during the meetings of the British Association in Dover and of the Association Française pour l'avancement de Science in Boulogne, a temporary installation was fixed in the Dover Town Hall, in order that members present should see the practical working of the system between England and France. Messages were exchanged with ease between Wimereux, near Boulogne, and Dover Town Hall. In this way it was possible for the members of the two associations to converse across the Channel, over a distance of 30 miles.

During Prof. Fleming's lecture on the "Centenary of the Electric Current," messages were transmitted direct to and received from France, and *viâ* the South Foreland Lighthouse to the East Goodwin Lightship. An interesting point was that it was demonstrated that the great masses of the Castle Rock and South Foreland cliffs lying between the Town Hall, Dover, and the lighthouse did not in the least degree interfere with the transmission of signals. This result was, however, by no means new. It only confirmed the results of many previous experiments, all of them showing that rock masses of very considerable size intervening between two stations do not in the least affect the freedom of communication by ether wave telegraphy. (See *Journal* of the Institution of Electrical Engineers, April 1899, p. 280.)

It was during these tests that it was found possible to communicate direct from Wimereux to Harwich or Chelmsford, the intervening distance being 85 miles. This result was published in a letter from Prof. Fleming addressed to the *Electrician* on September 29. The distance from Wimereux to Harwich is approximately 85 miles, and from Wimereux to Chelmsford also 85 miles, of which 30 miles are over sea and 55 over land. The height of the poles at these stations was 150 feet, but if it had been necessary for a line drawn between the tops of the masts to clear the curvature of the earth they would have had to have been over 1000 feet high. I give these results to show what satisfactory progress is being made with this system.

In America wireless telegraphy was used to report from the high seas the progress of the yachts in the International Yacht Race, and I think that occasion holds the record for work done in a given time, over four thousand words being transmitted in the space of less than five hours on several different days.

Some tests were carried out for the United States Navy; but, owing to insufficient apparatus, and to the fact that all the latest improvements had not been protected in the United States at that time, it was impossible to give the authorities there such a complete demonstration as was given to the British authorities during the naval manœuvres. Messages were transmitted between the battleship *Massachusetts* and the cruiser *New York* up to a distance of 36 miles.

A few days previous to my departure from America the war in South Africa broke out. Some of the officials of the American line suggested that, as a permanent installation existed at the Needles, Isle of Wight, it would be a great thing, if possible, to obtain the latest war news before our arrival on the *St. Paul* at Southampton. I readily consented to fit up my instruments on the *St. Paul*, and succeeded in calling up the Needles station at a distance of 66 nautical miles. By means of wireless telegraphy, all the important news was transmitted to the *St. Paul* while she was under way, steaming twenty knots, and messages were despatched to several places by passengers on board. News was collected and printed in a small paper called the *Transatlantic Times* several hours before our arrival at Southampton.

This was, I believe, the first instance of the passengers of a steamer receiving news while several miles from land, and seems to point to a not far distant prospect of passengers maintaining direct and regular communication with the land they are leaving and with the land they are approaching, by means of wireless telegraphy.

At the tardy request of the War Office, we sent out Mr. Bullocke and five of our assistants to South Africa. It was the intention of the War Office that the wireless telegraph should only be used at the base and on the railways, but the officers on the spot realised that it could only be of any practical use at the front. They therefore asked Mr. Bullocke whether he was willing to go to the front. As the whole of the assistants volunteered to go anywhere with Mr. Bullocke, their services were accepted, and on December 11 they moved up to the camp at De Aar. But when they arrived at De Aar, they found that no arrangements had been made to supply poles, kites, or balloons, which, as you all know, are an essential part of the apparatus, and none could be obtained on the spot. To get over the difficulty, they manufactured some kites, and in this they had the hearty assistance of two officers, viz. Major Baden-Powell and Captain Kennedy, R.E., who have often helped me in my experiments in England. (Major Baden-Powell, it will be remembered, is a brother of the gallant defender of Mafeking.)

The results which they obtained were not at first altogether satisfactory, but this is accounted for by the fact that the working was attempted without poles or proper kites, and afterwards with poles of insufficient height, while the use of the kites was very difficult, the kites being manufactured on the spot with very deficient material. The wind being so variable, it often happened that when a kite was flying at one station there was not enough wind to fly a kite at the other station with which they were attempting to communicate. It is therefore manifest that their partial failure was due to the lack of proper preparation on the part of the local military authorities, and has no bearing on the practicability and utility of the system when carried out under normal conditions.

It was reported that the difficulty of getting through from one station to another was due to the iron in the hills. If this had not been cabled from South Africa, it would hardly be credible that any one should have committed himself to such a very unscientific opinion. As a matter of fact, iron would have no greater destructive effect on these Hertzian waves than any other metal, the rays apparently getting very easily round or over such obstacles. A fleet of thirty ironclads did not affect the rays during the naval manœuvres, and during the yacht race I was able to transmit my messages with absolute success across the very high buildings of New York, the upper storeys of which are iron.

However, on getting the kites up, they easily communicated from De Aar to Orange River, over a distance of some seventy miles. I am glad to say that, from later information received, they have been able to obtain poles, which although not quite high enough for long distances are sufficiently useful. We have also sent a number of Major Baden-Powell's kites, which are the only ones I have found to be of real service.

Stations have been established at Modder River, Enslin, Belmont, Orange River, and De Aar, which work well and will be invaluable in case the field telegraph line connecting these positions should be cut by the enemy.

It is also satisfactory to note that the military authorities have lately arranged to supply small balloons to my assistants for portable installations on service waggons.

While I admire the determination of Mr. Bullocke and our assistants in their endeavour to do the very best they could with most imperfect local means, I think it only right to say that if I had been on the spot myself I should have refused to open any station until the officers had provided the means for elevating the wire, which, as you know, is essential to success.

Mr. Bullocke and another of our assistants in South Africa has been transferred with some of the apparatus to Natal to join General Buller's forces, and it is likely that before the campaign is ended wireless telegraphy will have proved its utility in actual warfare. Two of our assistants bravely volunteered to take an installation through the Boer lines into Kimberley; but the military authorities did not think fit to grant them permission, as it probably involved too great a risk.

What the bearing on the campaign would have been if working installations had been established in Ladysmith, Kimberley and Mafeking, before they were besieged, I leave military strategists to state. I am sure you will agree with me that it is much to be regretted that the system could not be got into these towns prior to the commencement of hostilities.

I find it hard to believe that the Boers possess any workable instruments. Some instruments intended for them were seized by the authorities at Cape Town. These instruments turned out to have been manufactured in Germany. Our assistants, however, found that these instruments were not workable. I need hardly add that as no apparatus has been supplied by us to any one, the Boers cannot possibly have obtained any of our instruments.

I have spoken at great length about the things which have been accomplished. I do not like to dwell upon what may, or will, be done in the immediate or more distant future, but there is one thing of which I am confident—viz. that the progress made this year will greatly surpass what has been accomplished during the last twelve months; and speaking what I believe to be sober sense, I say, that by means of the wireless telegraph, telegrams will be as common, and as much in daily use, on the sea as at present on land.

THE AIR MOVEMENT AT SIMLA AND IN THE WESTERN HIMALAYAS.[1]

IT will generally be admitted that the Meteorological Reports that are issued from time to time by the Indian authorities possess two very valuable features. The work is thorough in its execution, and the result derived is interesting. The present discussion of the air movement at Simla and in the Western Himalayas does not, in either novelty or importance, fall behind the other memoirs which have preceded it, although it presents only a portion of the full investigation, which, when complete, will embrace a similar discussion of the observations made at Darjeeling, a station as characteristic of the Eastern Himalayas, as Simla is of the Western. Two circumstances contribute to the interest attaching to this special inquiry. One is, that our knowledge of the behaviour of the winds in mountain areas is somewhat limited, both on the practical and theoretical side: consequently, a thorough study is particularly welcome. The other is the suitableness of the situation for such an inquiry, since the phenomena can exhibit themselves here on a large scale, and the influence of minor interfering effects be much eliminated. In Indian meteorology we have to deal with large masses of air, subject to periodic laws and partaking of the general movement of the air at the earth's surface. In this particular instance, we have the Indo-Gangetic plain stretching from the North Punjab to East Bengal, some 1350 miles long, and 200 miles in average breadth. The whole of this area is below 1000 feet in elevation, and probably averages barely 400 feet above the sea. From this plain the outer ranges of the Himalayas rise with remarkable abruptness over nearly the whole length. On the northern side, by way of contrast, we have the elevated tableland of Thibet, of which a considerable portion exceeds 14,000 feet in elevation, constituting the great protuberance above the general level of the earth's surface, of which the Himalaya and Karakoram mountains are nothing but the northern and southern borders. In this noble theatre and laboratory, the movements of the air peculiar to mountain areas can be studied with effect, and yet, by some strange perversity, the subject has been neglected. The knowledge which we have gained, and which is repeated in text-books, has unfortunately been derived from wind registers which were either not continuous in their action, or from which partial extracts have been made. The records selected for discussion were made at 8 and 10 a.m. and 4 p.m., consequently, the effect of the night winds, accompanying a fall of temperature, did not come within the scope of investigation. Moreover, the stations chosen for the anemometric instruments represented the characteristics of the air movement across the lower mountain ranges and not the local up and down movements in the deep valleys which lie between these ranges. It is therefore not surprising that the results derived from so partial a source need corrections, or that the accounts given by travellers through these districts, limited as they necessarily are to certain seasons of the year, do not adequately represent the whole of the observed phenomena.

In the opening pages Mr. Eliot briefly reviews the state of our knowledge, and sketches the work of his predecessors in office. The conclusions derived from this haphazard and intermittent kind of observation were to the effect that southerly winds prevail throughout the whole year at the Himalayan hill stations, indicating that in the south-west monsoon the lower air current extends to these elevations; whereas, in the cold weather, the air current giving these winds is the upper movement complementary to the north-westerly winds at the level of the plains. Moreover, the records indicated that the air movement is strongest in the Western Himalayas from January to April, and is feeblest during the monsoon period from June to September. To these statements, which have been frequently quoted, Sir Richard Strachey added, from his own experience and observation, that the most important feature of the air movement in the Western Himalayas was the up and down valley winds, blowing up the valleys during the day from 9 a.m. to 9 p.m. and down them during the corresponding hours of the night.

Mr. Eliot deals with these statements in the first series of tables founded on the records of a large Beckley anemometer, not particularly described. He gives the number of winds recorded under each of eight points of the compass for portions of the years 1893–1896, and derives the constants of the well-known Besselian formula representing the diurnal variation of the winds. The result is to show that the mean monthly air movement is in January and February approximately S.E., and for the remainder of the year is N. 46° E. as opposed to S. 61° W. from the partial records already referred to. Other deductions which come out of this preliminary inquiry show that the air movement is least during the rainy season of July and August, greatest from January to May, and that, since the mean movement is almost as great in January and February as in the hot weather months, it is not a function of the temperature. Mr. Eliot sums up the general conclusions in the following terms:—"The air moment at Simla varies slightly in strength throughout the year, but has two well-marked maxima and minima, in no way related directly to the seasons or to the air movement over the plains in Northern India. These facts alone constitute a strong proof of the inference that the air movement over the Himalayan area is a unique system, independent of the general air movement over the plains in Northern India, and dependent on local conditions and features."

Neither does the *diurnal* variation of the wind, whether in velocity or rotation, partake of that simple character which has been ascribed to it, but within a limited space it is not easy to summarise the results of the analysis applied. For Mr. Eliot

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[1] "Indian Meteorological Memoirs; being occasional discussions and compilations of meteorological data relating to India and the neighbouring countries." Vol. vi., Part 5. (Published by order of H.E. the Viceroy and Governor-General of India in Council, under the direction of John Eliot, M.A., F.R.S., C.I.E., Calcutta, 1899.)